

P-9 Indoor Environmental Remediation

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Disclosures

- Consultant/Advisory Board: Phadia
- Speaker: Merck, Phadia
- Honorarium: Merck, Phadia



Learning Objectives

Upon completion of this session, participants should be able to:

- Advise patients how to reduce exposure to furry animals
- Recommend abatement methods to eliminate rodents and other pests
- Describe effective recommendations for mold abatement



Definitions

- Remediation
 - Includes measures to reduce exposure when the source is still present.
 - Otherwise known as avoidance.
- Abatement
 - Measures to completely eliminate the exposure in an environment by removing its source.
 - The patient may still have exposure in other environments



Uses

- Remediation
 - Furry animals. Reduce exposure with the pet present
 - Home owners are hesitant to remove a beloved pet
- Abatement
 - Rodents. Most home owners don't want rats and mice running around
 - Cockroaches.
- Combined remediation and abatement
 - Fungi, dust mites, irritants
 - Impossible to completely remove sources so reduction is also needed



Procedures used for Exposure Reduction

- | | |
|----------------------|------------------------------------|
| Avoidance | Abatement |
| • Air filtration | • Removal of sources |
| • Denaturants | • Use of predators |
| • Washing | • Habitat modification |
| • Mattress encasings | • Rodenticides/Pesticides |
| • Vacuum cleaners | • Integrated Pest Management (IPM) |
| • Combinations | |



Air Filtration

HVAC Furnace Filters

- Panel filters;
- High-efficiency particulate air (HEPA) filters;
- Washable/reuseable filters;
- Powered electronic filters
- Hybrid combinations of the prior types.

Room Air Cleaners

- Ionizer air cleaners or purifiers
- HEPA room air cleaners
- Non-HEPA room air cleaners that contain disposable or washable filters

J Allergy Clin Immunol 2010;125:32-8.



Air Filtration: Health Effects

- Air filtration can reduce airborne particles
- Source control and ventilation are preferred to air cleaners
- Long-term use may benefit disease progression
- Portable room air cleaners with HEPA filters appear to be beneficial
- For HVAC, high-efficiency disposable filters with proper maintenance appears to be best

J Allergy Clin Immunol 2010;125:32-8.



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Denaturants

- Sodium hypochlorite (NaOCl) bleach (1)
 - Powerful oxidizer but can cause health problems
- Tannic Acid (2)
 - Denatures allergens temporarily.
 - Can stain fabrics
- Soft soap, guanidine hydrochloride and sodium lauryl sulphate (3)
 - Can denature cat and dust mite allergens

1. J Allergy Clin Immunol. 2009;124(4):731-8
2. J Allergy Clin Immunol. 1995;96(3):325-33
3. Ann Occup Hyg. 1990;34(2):215-29



Washing Pets

- Washing cats reduced airborne Fel d 1 3 hours later.
- Cats that were washed weekly for 5 weeks produced a mean decrease of 44% in airborne Fel d 1
- Washing by immersion for 3 minutes at weekly intervals for 1 month reduced airborne allergen by 79%
- This decrease was not maintained after 1 week¹
- Amount of Fel d 1 collected in the wash water decreased progressively over 4 weeks
- Most of the reduction in Fel d 1 occurred with the first wash while little or no change was observed in the last 3 washes²

¹ J Allergy Clin Immunol. 1997;100(3):307-12
² Am Rev Respir Dis. 1991;143(6):1334-9



Washing Pets (cont)

- Group 1: cats were washed with soap and warm water for 60 seconds
- Group 2: Cats were washed by immersion in warm tap water for 3 minutes while the pelt was massaged;
- Group 3: cats were washed as in Group 2 but rinsed for an additional 3 minutes.
- Increased amount of allergen in the bathwater with each additional intervention
- Cats should be washed as in Group 3.

J Allergy Clin Immunol. 1997;100(3):307-12



Mattress Encasings

- Vinyl and laminates
 - block all allergens including Fel d1
 - not air- or water vapor-permeable
 - are very uncomfortable
- woven microfiber fabric
- non-woven microfiber fabric

David Miller, MD. Personal communication.



Woven Microfiber Encasings

- Made from fabrics in which the yarns have been alternately woven above and below each other on a loom.
- The yarns each comprise 100-200 ultra-thin microfilaments.
- The tightly woven microfiber fabric acts as a filter that prevents allergen escape, yet allows air and water vapor to pass freely through the fabric.
- Woven microfiber fabrics with a mean pore size less than 10 microns; block Der p1, but only those with a mean pore size less than 6 microns block Fel d1.
- The mean pore size is only a surrogate measure of allergen impermeability
- Many commercially available woven microfiber encasings block Der p1 but not Fel d1

J Allergy Clin Immunol. 1999;103(2 Pt 1):227-31



Non-woven Fabrics

- Manufactured by fusing a mass of overlain short filaments to each other with heat, glue, and pressure.
- Similar in appearance to a paper towel with an embossed pattern on their surface.
- Do block Fel d1 passage.
- Depth of the interstices between the randomly crisscrossing fibers is deep enough to accumulate allergens—including Der p1, Der f1, and Fel d1
- Over time the patient is eventually sleeping on a layer of allergen.
- Non-woven encasings are not washable

J Allergy Clin Immunol. 2007;120(4):977-9



Vacuum Cleaners

Types of Vacuums

- Upright
- Cylinder
- Drum (shop vac)
- Hand held
- Robotic
- Central
- Cyclonic



Exhaust Filtration

- Bag
- Bagless
- Water filter
- Ultrafine
- HEPA



Vacuum Cleaning

- Increase in particles during the vacuuming for all models (1)
- High-efficiency and HEPA bags reduce redistribution of dust (2)
- Water-filtered increase exposure unless a second-stage filter is also installed (3)
- Long-term vacuuming (4 weeks) can reduce overall exposure to Der p1, Fel d1 and Can f1 (4)

1. Indoor Air. 2004;14(3):174-7
2. J Allergy Clin Immunol. 1999;104(5):1079-83
3. Allergy. 1998;53(4):411-4
4. Pediatr Allergy Immunol. 2000;11(3):142-8



Combination Measures

- Interventions:
 - 11 months of biweekly cat washing
 - use of mattress and pillow encasings
 - weekly washing of encasings at 60° C
 - excluding the cat from the bedroom
 - application of tannic acid
- Result:
 - Reduced *Fel d1* concentration in house dust by 91.4% in an active but not a control group.

J Allergy Clin Immunol. 1997;99:S388



Other Intervention Studies

- Intervention:
 - Cats washed weekly for 4 months
 - HEPA air cleaner and vacuum cleaner
 - Mattress covers
 - Reduced carpet
- Improved clinical and medication scores, bronchial hyperreactivity
- Reduced airborne *Fel d 1*

J Allergy Clin Immunol. 1995;95(1):263



Remove Sources

- Fungi:
 - Reduce sources of moisture
 - Intrusion, condensation, leakage
- Rodents, Cockroaches
 - Reduce sources of food, water, shelter
- Furry animals
 - Keep animal out of bedroom
 - Get rid of the animal



Use of Predators

- Rodents
 - Get a cat
 - Snakes, owls
- Insects
 - Spiders



Rodenticides/Pesticides

- Rodents:
 - Warfarin-like chemicals
 - Rats can figure it out. Pre-bait
 - Resistance forms
 - Harm to secondary predators that eat the rodent
- Cockroaches
 - Organochlorides, Organophosphates, Pyrethroids
 - Apply by professional exterminators
 - Resistance
 - Consider human health



Traps

- snap traps
- live traps
- glue boards



Goals of Remediation (US Dept of Housing & Urban Development)

- Keep It:
 - Dry
 - Clean
 - Safe
 - Well-Ventilated
 - Pest-Free
 - Contaminant-Free
 - Well-Maintained



Keep it Dry

Moisture Sources

- Intrusion
 - Roof, wall, window, foundation defects
 - Landscaping issues
- Leaks
- Condensation
 - Surfaces chilled below the dew point
- Construction Moisture

Moisture-related Health Effects

- Upper respiratory tract symptoms
- Coughing
- Wheezing
- Asthma symptoms
- Hypersensitivity pneumonitis

IOM Report



American Housing Survey – 2007

Interior Water Leakage

- 7.9% had interior water leakage in 12 month period
 - 2.1% from fixtures
 - 3.4% from leaking pipes
 - 0.8% from broken water heater
 - 2.0% from other or unknown causes
- The problem was worse for:
 - Renters – 10.7%
 - Manufactured housing – 8.7%
 - New move ins – 9.6%
- 3.8% of homes built from 2003 to 2007
 - Down from 5.5% from 2001 to 2005

Exterior Water Leakage

- 10.3% had exterior water leakage in 12 month period
 - 4.7% from the roof
 - 3.5% from the basement
 - 1.7% from the walls, closed windows or doors
 - 1.0% from other or unknown source
- The problem was worse for:
 - Northeast – 16.3%
 - Midwest – 13.3%
 - New move ins – 9.6%
- 5.6% of homes built from 2003 to 2007
 - Down from 6.4% from 2001 to 2005

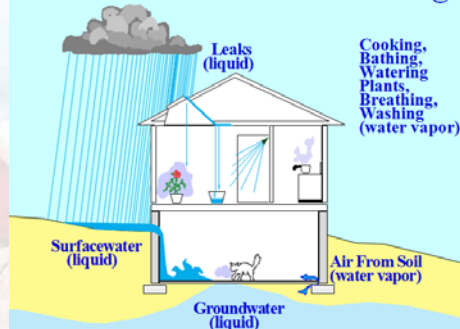


Comfort Levels

- Air temperature: 65°F (active) – 80°F (bathing)
- Air relative humidity: 30% – 70%
- Air motion: 20 – 40 feet per minute
- Surrounding surface temperatures: within 10 – 15°F of room air



How Water Enters a Building



Keep it Clean

What to Reduce

- Reduced exposure to:
 - Chemical contaminants
 - Allergens
 - Pest droppings and urine
 - Pesticides and consumer chemicals
 - Heavy metals such as lead and arsenic
- Reduced harborage for pests

More Cleanable Buildings

- Install dust walk-off systems at entryways
- Keep activities which create dust away from people.
- Provide smooth, cleanable surfaces
- Provide effective storage space (to help avoid clutter)
- Choose flooring that is easy to clean
- Use vacuums that have good filtration and can be emptied quickly and thoroughly



Keep it Well-Ventilated

- Ventilation vs. Circulation
- Pollutants can be found in concentrations 2-5 times higher indoors than outdoors.
- Proper ventilation can reduce hazards of:
 - Volatile organic compounds
 - Moisture
 - Environmental tobacco smoke
 - Particulate matter
 - Allergens
 - Mold
 - Carbon monoxide
 - Formaldehyde



Ventilation

Combustion Gases

- Carbon Monoxide
 - Fatigue, headaches, dizziness, confusion
 - The “Silent Killer”
- Nitrogen Dioxide
 - Eye, nose, and throat irritation
 - Shortness of breath

Need Exhaust Vent

- Bathrooms
- Clothes dryers
- Kitchen ranges
- Boilers, furnaces, hot water heaters
- Fireplaces, wood burning stoves



Keep it Pest-Free

From a study of 622 rat bites in Philadelphia:

- Majority of bites occurred in the bedroom, between 12 midnight and 8 AM
- Most bites occurred in the warmer months.
- More bites in communities below the poverty level
- 86% of victims were sleeping when bitten
- The highest proportion of victims were children less than 1 year of age



How common are rodents?

- Signs of rodents in last three months
 - Rats
 - 0.7% homes overall
 - 1.0% for renters
 - 1.4% for residents below poverty level
 - Mice
 - 5.5% homes overall
 - 6.0% for renters
 - 9.0% for manufactured housing.
 - 8.1% for residents below poverty level.
- Cockroaches, bed bugs and other pests not measured

From American Housing Survey – 2007



Integrated Pest Management

- Keep them out and give them no place to hide
 - Change surrounding landscape
 - Block pest entries, passages, hiding places
- Reduce food availability
 - Practice proper food storage and disposal
 - No dirty dishes in the sink overnight
 - Clean crumbs, grease etc.
- Knock down population
 - Traps
 - Appropriate pesticides

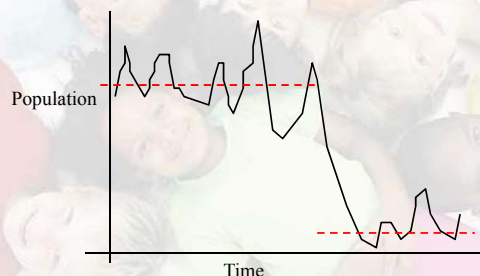


IPM

- Keep pests out and eliminate places to hide
 - Change surrounding landscape
 - Block pest entries, passages, hiding places
- Reduce food availability
 - Practice proper food storage and disposal
 - No dirty dishes in the sink overnight
 - Clean crumbs, grease etc.
- Knock down population
 - Traps
 - Appropriate pesticides



Change the carrying capacity of the building –
intervening in food, water, shelter or dating bars.



Integrated Pest Management

- **Intervention:**
 - Filling holes with copper mesh
 - Vacuuming
 - Cleaning
 - Baited traps with low-toxicity pesticides
- **Reduced Mus m1 more than 75% in kitchens and bedrooms (1)**
- **When facilitated but performed by home owners: (2)**
 - Reduced Mus m1 by 27%
 - Minimal clinical benefit unless reduced by 50%

1. Ann Allergy Asthma Immunol. 2004;92(4):420-5
2. Ann Allergy Asthma Immunol. 2008;101(1):35-41



Habitat Modification

Specialized Cleaning

- Reduce food sources and degrease
- Vacuuming
 - Hard to reach locations and places pests frequent
 - Direction of work: work from top to bottom
- Washing hard surfaces and floors
 - De-grease oven, stove, and counters
 - Two-bucket method
 - Restrict water distribution
 - Spray-bottle application

Storage Practices

- Food materials: Store in pest-resistant or pest-proof containers
- Essential non-food materials & goods: Store in an organized fashion so that any pest/vector activities can be readily observed
- Clutter: Reduce or eliminate non-essential stored items



Keep it Contaminant-Free

ETS

- Increases the number of episodes and severity of symptoms for children with asthma
- Risk factor for new cases of asthma in children
- Responsible for 150,000 to 300,000 lower respiratory tract infections in infants and children less than 18 months of age
- 60% of US population has biological evidence of exposure to second hand smoke

VOCs

- Air Fresheners
- Cleaning Products
- Sprays & Coatings
- Formaldehyde
- Carpets
- Vinyl Floors
- Drywall
- Hobbies
- Home Maintenance



A Systematic Review of Housing Interventions and Health: Introduction, Methods, and Summary Findings

David E. Jacobs, PhD, CIH; Mary Jean Brown, ScD, RN; Andrea Baeder, MPH; Marissa Scallia Sucosky, MPH; Stephen Margolis, PhD; Jerry Hershovitz, BS; Laura Kolb, MPH; Rebecca L. Morley, MSFP

CDC and National Center for Healthy Housing Report

- **Sufficient Evidence:**
 - Cockroach control through integrated pest management (reduce allergens)
 - Combined elimination of moisture intrusion and leaks and removal of moldy items
 - Smoke-free policies
 - Installed, working smoke alarms to reduce fire deaths and injuries
 - Preset safe temperature hot water heaters to prevent scald burns

J Public Health Management Practice, 2010, September(Suppl), S3-S8



Needs More Evaluation

- Improved insulation (reduce moisture and mold exposure and improve general and respiratory health status)
- Repeated vacuuming and steam cleaning of carpeting and furnishings (reduce allergens)
- HEPA air filtration (to reduce asthma)
- Ventilation and dehumidification
- Portable HEPA cleaners to reduce indoor particulates
- Particulate control by envelope sealing
- Working air-conditioning during heat waves

J Public Health Management Practice, 2010, September(Suppl), S3-S8



No Evidence for Benefit

- Bedding encasement and/or sheet and/or upholstery cleaning alone
- Acaracides as a single intervention
- Air cleaners releasing ozone
- Portable HEPA air cleaners to reduce secondhand smoke or gases

J Public Health Management Practice, 2010, September(Suppl), S3-S8



What do Allergists Recommend?

Percentage of respondents recommending specific measures from guidelines for the control of indoor allergen exposure*

Dust mite allergen intervention (%)	Animal allergen intervention (%)	Cockroach allergen intervention (%)	Mold allergen intervention (%)
Bedding recommendations	97	Remove pet from house	77
Wash bedding weekly in hot water	91	Remove pet to another area	6
Vacuum weekly with good quality bags in various locations	83	Remove pet from bedrooms	92
Before school release readiness	75	Air filtration	61
Replace carpet, upholstered furniture, and draperies	68	Carpet and other materials removal	1.25
Avoid living in basements	6	Mattress and pillow cover	28
		Use of house acid	0.25
		Wash pet	63

J Allergy Clin Immunol. 2008 April ; 121(4): 1053-1054



Compliance with EC

Respondents' perception of patient compliance with EC recommendations

Patients complying with EC	Few	Some	Many	Most
Patients implementing at least 1 EC intervention before the initial visit	71	15	10	4
Patients implementing no EC intervention after the initial visit	60	21	14	5
Patients implementing some EC interventions after the initial visit	18	38	34	11
Patients implementing many to most EC interventions after the initial visit	82	12	6	0

J Allergy Clin Immunol. 2008 April ; 121(4): 1053-1054



Techniques for Allergen Reduction (Insect and Rodent Pests)

- Environmental (Indoor and Outdoor):**
 - Remove Attractants
 - Landscaping and Vegetation Management (Prune Trees and Ornamentals)
 - Ventilation, Temperature, and Moisture Control
 - Trash Removal and Well Placed Dumpster Site
- Sanitary:**
 - General Housekeeping
 - Detailed Cleaning
 - Sealing (Caulking, Metal Mesh, Expandable Spray Foams and Gels)
 - Clutter Reduction
 - Storage Practices
 - Disposal Frequency
- Non-Chemical Extermination:**
 - Traps (sticky, snap, curiosity, light, etc)
 - Biologicals and Pheromones
 - Predators and Parasites
 - Vacuuming
 - Freeze, Heat, or Steam
 - Repellants
 - Ultrasound
 - Lighting
- Chemical Extermination:**
 - Insecticides and Rodenticides
 - Formulations (Baits, etc.)
 - Insect Growth Regulators
- Public Policy:**
 - Legal Housing Codes (Development and Enforcement)
 - City Housing and Environmental Commissions
 - Neighborhood Housing Coalitions



Dust Mite Avoidance

- First Level**
 - Encase the pillow and mattress with a pore diameter no larger than 10 microns
 - Wash bedding weekly in hot water and dry in a heated drier
 - Remove dust mite reservoirs such as toys and stuffed animals from the bed
 - Keep humidity less than 50%
 - Vacuum with a HEPA filter bag
 - Chemicals to kill mites or denature proteins have a modest effect
- Second Level**
 - Remove upholstered furniture, drapery, carpeting or rugs
- Third Level**
 - Move from a damp location such as a basement to a higher floor



Pet Allergens

- Control allergen with pet removed from the home**
 - Thoroughly clean upholstered furniture, walls and carpet
 - Removal of furniture and carpet is ideal
- Control allergen with pet in the home**
 - Remove pet from the bedroom and other rooms where your child spends a lot of time
 - Aggressive cleaning of upholstered furniture, walls and carpet
 - Removal of upholstered furniture and carpet is ideal
 - Encase the mattress and pillows with a pore diameter no larger than 6 microns
 - Keep the pet clean. Washing dogs twice a week may be helpful.
 - Use a HEPA air filter



Cockroach and Mouse

- Inspect to detect hiding places and identify food sources (grease, kitchen debris)
- Store food in sealed containers. Avoid exposed pet food
- Remove clutter
- Exterminate with pesticides or bait traps. Professional extermination is preferred
- Seal holes or cracks in the home to prevent re-infestation
- Wash bedding, curtains and clothing

